MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

EMF3066 – ANTENNA AND PROPAGATION
(TE)

14 JULY 2023
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages with 4 Questions only.
2. Attempt **ALL** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Sketch the radiation patterns of an isotropic antenna and short dipole in two-dimensional and three-dimensional co-ordinate system. Show their directivities in the co-ordinate systems.

[7 marks]

(b) An antenna test range is to be used to measure far field radiation pattern of a newly designed antenna. The frequency range of interest is from 900 MHz to 1.8 GHz. The largest dimension of the antenna, D is b. Determine the required minimum distance for the test range to obtain far field radiation pattern.

Use b = (40 + last two digits of your ID/ 100) cm.

[8 marks]

(c) Draw the equivalent circuit of a receiving Hertzian dipole and derive the expression of its effective aperture as a function of directivity D and wavelength λ.

[10 marks]

Question 2

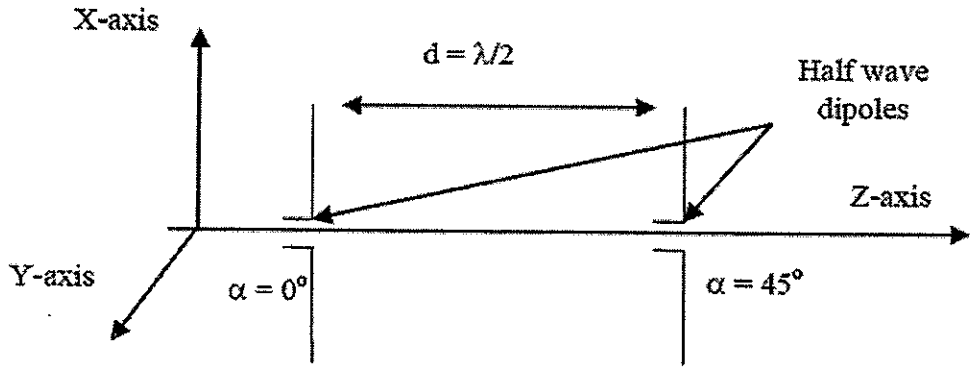

Figure Q2

An array is constructed with two half-wave dipoles spaced half-wavelength apart ($d=\lambda/2$). The dipoles are arranged along the Z-axis, with the dipole oriented parallel to the X-axis, as shown in Figure Q2. The dipoles are fed with equal power and have a progressive phase shift (α) of 45° between elements.

(a) Determine the array factor for this arrangement.

[8 marks]

Continued .....

(b) Calculate the pattern nulls and pattern maximum for this array.

[8 marks]

(c) Sketch the total pattern that includes the array factor and element pattern. [9 marks]

Question 3

(a) Based on the definition of smart antenna, one can define "levels of Intelligence". Name three types of "levels of Intelligence" and explain them with the aid of diagrams.

[8 marks]

(b) Design a 10-turn helix to operate in the axial mode. For an optimum design, determine the:

(i) Circumference (in λ_o),
(ii) Pitch angle (in degrees)
(iii) Separation between turns (in λ_o)
(iv) Half-power beamwidth of the main lobe (in degrees)
(v) Directivity (in dB)
(vi) Axial ratio (dimensionless and in dB)

[1.5 marks × 6]

(c) List the FOUR (4) advantages and FOUR (4) disadvantages of the microstrip patch antenna.

[8 marks]

Question 4

(a) With the aid of diagram, illustrate the FIVE (5) layers found in the earth's atmosphere.

[7 marks]

(b) Given that a transmitting antenna has a gain of 50 dBi and radiates at 15 W at a frequency of 8 GHz. Find the received power at a distance of 20 km if similar antenna is used as receiving antenna.

[7 marks]

Continued .....

(c) Sky wave communication between two points on earth's surface at a distance 2500km is to be established using reflection from F1 layer at a virtual height, h of 200km. The critical frequency is 4 MHz at the reflection point. The effective Earth radius due to refraction, R' is 8500km.

i. Determine the electron density at the reflection point.
ii. Find the maximum usable frequency (MUF) and the optimum working frequency (OWF).
iii. Ignoring collisions, determine the refractive index of ionosphere at 200km virtual height for OWF. Discuss this result.

[3 + 4 + 4 marks]

Hints:

$$\sin\theta_i = \frac{\sin\frac{d}{2R'}}{\sqrt{\left(\frac{h}{R'}\right)^2 + \left(1+\frac{h}{R'}\right)\sin^2\frac{d}{4R'}}}$$

where θ_i = angle of incidence and d = skip distance

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